RAK11300 Module AT Command Manual

Introduction

RAK11300 WisDuo LPWAN Module is based on the Raspberry Pi RP2040 chip and SX1262 RF transceiver. It provides an easy-to-use, small-size, low-power solution for long-range wireless data applications. This module complies with Class A & C of LoRaWAN 1.0.2 specifications. It can easily connect to different LoRaWAN server platforms like TheThingsNetwork (TTN), Chirpstack, Helium, etc. It also supports LoRa Point-to-Point (P2P) communication mode which helps you in implementing your own customized long-range LoRa network quickly.

The AT commands can be interfaced via USB acting as a serial port (Pin 2 **USB_DM** and Pin 3 **USB_DP**) or via UART1 (Pin 10 **TX1** and Pin 9 **RX1**). The default parameter of the AT commands is fixed to **115200 / 8-N-1**. The firmware upgrade is only possible via USB. To get familiar with the pin distribution of this module and find a schematic circuit of a reference application, refer to the RAK11300 Module Datasheet.

Content

- RAK11300 Module AT Command Manual
  - Introduction
  - Content
  - AT Command Syntax
  - AT?
  - ATR
  - ATZ
  - AT+APPEUI
  - AT+APPKEY
  - AT+DEVEUI
  - AT+APPSKEY
  - AT+NWKSKEY
  - AT+DEVADDR
  - AT+CFM
  - AT+JOIN
  - AT+NJS
  - AT+NJM
  - AT+SENDFREQ
  - AT+SEND
  - AT+ADR
  - AT+CLASS
  - AT+DR
  - AT+TXP
  - AT+BAND
  - AT+MASK
  - AT+BAT
  - AT+RSSI
  - AT+SNR
  - AT+VER
  - AT+STATUS
  - Appendix
    - Appendix I Data Rate by Region
    - Appendix II TX Power by Region
    - Appendix III Maximum Transmission Load by Region

AT Command Syntax

The AT command is based on ASCII characters. In general, the AT Command starts with the prefix `AT` and ends with `<CR><LF>` (i.e. \r\n). For the rest of the document, the `\r\n` part is omitted for the sake of clarity.

The AT commands have the standard format “AT+XXX”, with XXX denoting the command.

There are four available command formats:

AT COMMAND FORMAT	Description
`AT+XXX?`	Provides a short description of the given command
`AT+XXX=?`	Reading the current value on the command
`AT+XXX=<input parameter>`	Writing configuration on the command
`AT+XXX`	Used to run a command

The output of the commands is returned via UART.

The format of the reply is divided into two parts: returned value and the status return code.

> 📝 **NOTE:**
>
> `<CR>` stands for “carriage return” and `<LF>` stands for “line feed”.

1. **`<value><CR><LF>`** is the first reply when (**`AT+XXX?`**) command description or (**`AT+XXX=?`**) reading value is executed then it will be followed by the status return code. The formats with no return value like (**`AT+XXX=<input parameter>`**) writing configuration command and (**`AT+XXX`**) run command will just reply to the status return code.
2. **`<CR><LF><STATUS><CR><LF>`** is the second part of the reply which is the status return code.

The possible status codes are:

STATUS RETURN CODE	Description
`OK`	Command executed correctly without error.
`+CME ERROR:1`	Generic error or input is not supported.
`+CME ERROR:2`	Command not allowed.
`+CME ERROR:5`	The input parameter of the command is wrong.
`+CME ERROR:6`	The parameter is too long.
`+CME ERROR:8`	Value out of range.

More details on each command description and examples are given in the remainder of this section.

> 📝 **NOTE:**
>
> After changing LoRaWAN® parameters, the device must be reset by either the `ATZ` command or pushing the reset button.
>
> The Serial port connection is lost after the `ATZ` command or pushing the reset button. The connection must be re-established on the connected computer before log output can be seen or AT commands can be entered again.

AT?

Description: Help

Returns a list of all available commands with a short description

Command	Input Parameter	Return Value	Return Code
`AT?`	-	*List of commands*	`OK`

```
AT?
AT?

+++++++++++++++
AT command list
+++++++++++++++
AT?     AT commands
ATR     Restore default
ATZ     ATZ Trig a MCU reset
AT+APPEUI       Get or set the application EUI
AT+APPKEY   Get or set the application key
AT+DEVEUI   Get or set the device EUI
AT+APPSKEY  Get or set the application session key
AT+NWKSKEY  Get or Set the network session key
AT+DEVADDR  Get or set the device address
AT+CFM  Get or set the confirm mode
AT+JOIN Join network
AT+NJS  Get the join status
AT+NJM  Get or set the network join mode
AT+SENDFREQ Get or Set the automatic send time
AT+SEND Send data
AT+ADR  Get or set the adaptive data rate setting
AT+CLASS    Get or set the device class
AT+DR   Get or Set the Tx DataRate=[0..7]
AT+TXP  Get or set the transmit power
AT+BAND Get and Set number corresponding to active regions
AT+MASK Get and Set channels mask
AT+BAT  Get battery level
AT+RSSI Last RX packet RSSI
AT+SNR  Last RX packet SNR
AT+VER  Get SW version
AT+STATUS   Show LoRaWAN status
+++++++++++++++

OK
```

Back

ATR

This command is used to restore all parameters to the initial default values of the module.

Command	Input Parameter	Return Value	Return Code
`ATR?`	-	-	`OK`
`ATR`	-	-	`OK`

Back

ATZ

Description: MCU reset

This command is used to trigger an MCU reset.

Command	Input Parameter	Return Value	Return Code
`ATZ?`	-	`ATZ: Trig a MCU reset`	`OK`
`ATZ`	-	*No return. MCU resets.*	`OK`

Back

AT+APPEUI

Description: Application unique identifier

This command is used to access and configure the APPEUI.

Command	Input Parameter	Return Value	Return Code
`AT+APPEUI?`	-	`AT+APPEUI` : Get or set the App Eui	`OK`
`AT+APPEUI=?`	-	*< 8 hex >*	`OK`
`AT+APPEUI=<Input Parameter>`	*< 8 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+APPEUI?

+APPEUI: Get or set the application EUI
OK

AT+APPEUI=?

AT+APPEUI:70b3d57ed00201e1
OK

AT+APPEUI=70b3d57ed00201e1

OK

AT+APPEUI=70b3d57ed00201eh

+CME ERROR:5
```

Back

AT+APPKEY

Description: Application key

This command is used to access and configure the APPKEY.

Command	Input Parameter	Return Value	Return Code
`AT+APPKEY?`	-	`AT+APPKEY` : Get or set the Application Key	`OK`
`AT+APPKEY=?`	-	*< 16 hex >*	`OK`
`AT+APPKEY=<Input Parameter>`	*< 16 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+APPKEY?

AT+APPKEY: Get or set the application key
OK

AT+APPKEY=?

AT+APPKEY:2b84e0b09b68e5cb42176fe753dcee79
OK

AT+APPKEY=2b84e0b09b68e5cb42176fe753dcee79

OK

AT+APPKEY=2b84e0b09b68e5cb42176fe753dcee7x

+CME ERROR:5
```

Back

AT+DEVEUI

Description: Device EUI or DEVEUI

This command is used to access and configure the device EUI or DEVEUI.

Command	Input Parameter	Return Value	Return Code
`AT+DEVEUI?`	-	`AT+DEVEUI` : Get or set the Device EUI	`OK`
`AT+DEVEUI=?`	-	*< 8 hex >*	`OK`
`AT+DEVEUI=<Input Parameter>`	*< 8 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+DEVEUI?

+DEVEUI: Get or set the device EUI
OK

AT+DEVEUI=?

+DEVEUI:ac1f09fffe03efdc
OK

AT+DEVEUI=ac1f09fffe03efdc

OK

AT+DEVEUI=ac1f09fffe03efdx

+CME ERROR:5
```

Back

AT+APPSKEY

Description: Application session key

This command is used to access and configure the application session key or APPSKEY.

Command	Input Parameter	Return Value	Return Code
`AT+APPSKEY?`	-	`AT+APPSKEY` : Get or set the Application Session Key	`OK`
`AT+APPSKEY=?`	-	*< 16 hex >*	`OK`
`AT+APPSKEY=<Input Parameter>`	*< 16 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+APPSKEY?

AT+APPSKEY: Get or set the application session key
OK

AT+APPSKEY=?

AT+APPSKEY:3f6a66459d5edca63cbc4619cd61a11e
OK

AT+APPSKEY=3f6a66459d5edca63cbc4619cd61a11e

OK

AT+APPSKEY=3f6a66459d5edca63cbc4619cd61a11x

+CME ERROR:5
```

Back

AT+NWKSKEY

Description: Network session keys

This command is used to access and configure the network session keys or NWKSKEY.

Command	Input Parameter	Return Value	Return Code
`AT+NWKSKEY?`	-	`AT+NWKSKEY` : Get or set the Network Session Key	`OK`
`AT+NWKSKEY=?`	-	*< 16 hex >*	`OK`
`AT+NWKSKEY=<Input Parameter>`	*< 16 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+NWKSKEY?

AT+NWKSKEY: Get or Set the network session key
OK

AT+NWKSKEY=?

AT+NWKSKEY:323d155a000df335307a16da0c9df53f
OK

AT+NWKSKEY=323d155a000df335307a16da0c9df53f

OK

AT+NWKSKEY=323d155a000df335307a16da0c9df53f0

+CME ERROR:5
```

Back

AT+DEVADDR

Description: Device address or DEVADDR

This command is used to access and configure the device address or DEVADDR.

Command	Input Parameter	Return Value	Return Code
`AT+DEVADDR?`	-	`AT+DEVADDR` : Get or set the device address	`OK`
`AT+DEVADDR=?`	-	*< 4 hex >*	`OK`
`AT+DEVADDR=<Input Parameter>`	*< 4 hex >*	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+DEVADDR?

AT+DEVADDR: Get or set the device address
OK

AT+DEVADDR=?

AT+DEVADDR:26021FB0

OK

AT+DEVADDR=26021FB0

OK

AT+DEVADDR=26021FBX

+CME ERROR:5
```

Back

AT+CFM

Description: Confirmed payload mode

This command is used to access and configure the type of payload of the device.

Command	Input Parameter	Return Value	Return Code
`AT+CFM?`	-	`AT+CFM` : Get or set the confirm mode	`OK`
`AT+CFM=?`	-	**0** (if Unconfirmed) or **1** *if confirmed)	`OK`
`AT+CFM=<Input Parameter>`	**0** or **1**	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+CFM?

AT+CFM: Get or set the confirm mode
OK

AT+CFM=?

AT+CFM:0
OK

AT+CFM=0

OK

AT+CFM=3

+CME ERROR:5
```

Back

AT+JOIN

Description: Join the LoRaWAN® network

This command is used to join a LoRaWAN® network.

Command	Input Parameter	Return Value	Return Code
`AT+JOIN?`	-	`AT+JOIN` : Join network	`OK`
`AT+JOIN=?`	-	*Param1, Param2, Param3, Param4*	`OK` or `AT_BUSY_ERROR`
`AT+JOIN=<Input Parameter>`	*Param1:Param2:Param3:Param4*	-	`OK`
	Param1 = **Join command**: 1 for joining the network, 0 for stop joining		
	Param2 = **Auto-Join config**: 1 for Auto-join on power up), 0 for no auto-join. (0 is default)		
	Param3 = **Reattempt interval**: 7 - 255 seconds (30 is default)		
	Param4 = **No. of join attempts**: 0 - 255 (0 is default)		

> 📝 **NOTE**
>
> - This is an asynchronous command. `OK` means that the device is joining. The completion of the JOIN can be verified with `AT+NJS=?` command.
> - Param3 is not supported yet and is fixed to 30 seconds always.

Examples:

```
AT+JOIN?

AT+JOIN: Join network
OK

AT+JOIN=?

AT+JOIN=0:1:8:10
OK

AT+JOIN=1:1:8:10

OK

AT+JOIN=SUCCESS

AT+JOIN=3:1:8:10

+CME ERROR:5
```

Back

AT+NJS

Description: Network join status

This command is used to check the status of the devices if it is connected to a LoRaWAN® network.

Command	Input Parameter	Return Value	Return Code
`AT+NJS?`	-	`AT+NJS` : Get the join status	`OK`
`AT+NJS=?`	-	**0** (not joined) or **1** (joined)	`OK`

Examples:

```
AT+NJS?

AT+NJS: Get the join status
OK

AT+NJS=?

AT+NJS:1
OK
```

Back

AT+NJM

Description: LoRaWAN® network join mode

This command is used to access and configure the activation method of the device either OTAA or ABP. A value of 1 means OTAA join mode, a value of 0 means ABP join mode

Command	Input Parameter	Return Value	Return Code
`AT+NJM?`	-	`AT+NJM` : Get or set the network join mode	`OK`
`AT+NJM=?`	-	**0** or **1**	`OK`
`AT+NJM=<Input Parameter>`	**0** or **1**	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+NJM?

AT+NJM: Get or set the network join mode
OK

AT+NJM=?

AT+NJM:0
OK

AT+NJM=0

OK

AT+NJM=2

+CME ERROR:5
```

Back

AT+SENDFREQ

Description: Set the automatic transmission period

This command is used to set the period in seconds between automatic packet transmissions. If set to 0, automatic packet transmission is disabled.

Command	Input Parameter	Return Value	Return Code
`AT+SENDFREQ?`	-	`AT+SENDFREQ` : Get or set the automatic send time	`OK`
`AT+SENDFREQ=?`	-	`<period in seconds>`	`OK`
`AT+SENDFREQ=<Input Parameter>`	`<period in seconds>`	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+SENDFREQ?

AT+SENDFREQ: Get or Set the automatic send time
OK

AT+SENDFREQ=?

AT+SENDFREQ:60
OK

AT+SENDFREQ=60

OK
```

Back

AT+SEND

Description: Send payload data

This command is used to send the LoRaWAN® payload to a specific port.

Command	Input Parameter	Return Value	Return Code
`AT+SEND?`	-	`AT+SEND` : Send data	`OK`
`AT+SEND=<Input Parameter>`	`port:payload`	-	`OK` , `AT_NO_NETWORK_JOINED` , `AT_PARAM_ERROR` , or `AT_BUSY_ERROR`

Examples:

```
AT+SEND?

AT+SEND: Send data
OK
```

Unconfirmed Payload

```
AT+SEND=2:1234

OK

AT+SEND=SUCCESS
```

Confirm Payload

```
AT+SEND=2:1234

OK

AT+SEND=SUCCESS
```

Downlink packet received

> 📝 **NOTE:**
>
> - If there is a pending downlink message from the LNS (LoRaWAN Network Server), the downlink payload will be received after the `AT+SEND` command with the format `<fport>:<data length>:<rssi>:<snr>:<data>`.
> - In this example, the format has the corresponding values:
> - **fport**: 2
> - **data length**: 6
> - **rssi**: -46 dBm
> - **snr**: 11 dB
> - **data payload**: 48656C6C6F0A

```
AT+SEND=5:10AAFF45

OK

AT+SEND=SUCCESS
RX:2:6:-46:11:48656C6C6F0A
OK
```

Back

AT+ADR

Description: Adaptive data rate

This command is used to access and configure the adaptive data rate of the module.

Command	Input Parameter	Return Value	Return Code
`AT+ADR?`	-	`AT+ADR` : Get or set the Adaptive Data Rate setting	`OK`
`AT+ADR=?`	-	**0** (ADR off) or **1** (ARD on)	`OK`
`AT+ADR=<Input Parameter>`	**0** or **1**	-	`OK` or `AT_PARAM_ERROR`

Examples:

```
AT+ADR?

+ADR: Get or set the adaptive data rate setting
OK

AT+ADR=?

AT+ADR:0
OK

AT+ADR=0

OK

AT+ADR=3

+CME ERROR:5
```

Back

AT+CLASS

Description: LoRaWAN® class

This command is used to access and configure the LoRaWAN® class of the module.

Command	Input Parameter	Return Value	Return Code
`AT+CLASS?`	-	`AT+CLASS` : Get or set the Device Class (A, B, C)	`OK`
`AT+CLASS=?`	-	**A** or **C** (B not supported)	`OK`
`AT+CLASS=<Input Parameter>`	**A** or **C**	-	`OK` or `AT_PARAM_ERROR`

This FW of the device supports the LoRaWAN® V1.0.2 stack.

Examples:

```
AT+CLASS?

+CLASS: Get or set the device class
OK

AT+CLASS=?

AT++CLASS:A
OK

AT+CLASS=A

OK

AT+CLASS=F

+CME ERROR:5
```

Back

AT+DR

Description: Data rate settings

This command is used to access and configure data rate settings.

Command	Input Parameter	Return Value	Return Code
`AT+DR?`	-	`AT+DR=<DataRate><CR>` : Get or set the Tx Data Rate	`OK`
`AT+DR=?`	-	`0` , `1` , `2` , `3` , `4` , `5` , `6` , `7`	`OK`
`AT+DR=<Input Parameter>`	`0` , `1` , `2` , `3` , `4` , `5` , `6` , `7`	-	`OK` or `AT_PARAM_ERROR`

Check Appendix I for the input parameter depending on the frequency band selected.

Examples:

```
AT+DR?

AT+DR: Get or Set the Tx DataRate=[0..7]
OK

AT+DR=?

AT+DR:3
OK

AT+DR=3

OK
```

Back

AT+TXP

Description: Transmit Power

This command is used to access and configure the transmit power.

Command	Input Parameter	Return Value	Return Code
`AT+TXP?`	-	`AT+TXP` : Get or set the transmit power	`OK`
`AT+TXP=?`	-	< *value* >	`OK` or `AT+PARAM_ERROR`
`AT+TXP=<Input Parameter>`	< *value* >	-	`OK` or `AT_PARAM_ERROR`

Check Appendix II for the input parameter depending on the frequency band selected.

For example, at EU868, a value of 2 represents **MaxEIRP - 4 dB** where MaxEIRP = +16 dBm.

Examples:

```
AT+TXP?

AT+TXP: Get or set the transmit power
OK

AT+TXP=?

AT+TXP:0
OK

AT+TXP=0

OK
```

Back

AT+BAND

Description: Regional frequency band

This command is used to access and configure the regional frequency band.

Command	Input Parameter	Return Value	Return Code
`AT+BAND?`	-	`AT+BAND` : Get and Set number corresponding to active regions	`OK`
`AT+BAND=?`	-	`0` , `1` , `2` , `3` , `4` , `5` , `6` , `7` , `8` , `9` , `10` , `11` , `12`	`OK`
`AT+BAND=<Input Parameter>`	*< 0 to 12 >*	-	`OK` or `AT_PARAM_ERROR`

List of Band Parameter Options

Code	Regional Band	Code	Regional Band
0	AS923-1	7	IN865
1	AU915	8	US915
2	CN470	9	AS923-2
3	CN779	10	AS923-3
4	EU433	11	AS923-4
5	EU868	12	RU864
6	KR920		

Examples:

```
AT+BAND?

AT+BAND: Get and Set number corresponding to active regions
OK

AT+BAND=?

AT+BAND:10
OK

AT+BAND=10

OK

AT+BAND=22

+CME ERROR:8
```

Back

AT+MASK

Description: Regional channel mask

This command is used to access and configure the regional channel mask. Channel mask can only be set for the following regions: AU915, CN470, and US915

Command	Input Parameter	Return Value	Return Code
`AT+MASK?`	-	`AT+MASK: Get and Set channels mask`	`OK`
`AT+MASK=?`	-	`1`, `2`, `3`, `4`, `5`, `6`, `7`, `8`, `9`, `10`, `11`, `12`	`OK`
`AT+MASK=<Input Parameter>`	*< 0 to 12 >*	-	`OK` or `AT_PARAM_ERROR`

List of mask channels per region

Mask (Sub-Band)	US915	AU915	CN470
1	0-7	0-7	0-7
2	8-15	8-15	8-15
3	16-23	16-23	16-23
4	24-31	24-31	24-31
5	32-39	32-39	32-39
6	40-47	40-47	40-47
7	48-55	48-55	48-55
8	56-63	56-63	56-63
9	-	-	64-71
10	-	-	72-79
11	-	-	80-87
12	-	-	88-95

Examples:

```
AT+MASK?

AT+MASK: Get and Set channels mask
OK

AT+MASK=?

AT+MASK:10
OK

AT+MASK=10

OK

AT+MASK=13

+CME ERROR:8
```

Back

AT+BAT

Description: Read the battery voltage

This command is used to read the battery voltage of the device

Command	Input Parameter	Return Value	Return Code
`AT+BAT?`	-	`AT+BAT` : Get battery level	`OK`
`AT+BAT=?`	-	*< value >*	`OK` or `AT+PARAM_ERROR`

> 📝 **NOTE:**
>
> ***The battery level is returned as a value between 0 and 255***.

Examples:

```
AT+BAT?

+BAT:"Get battery level"
OK

AT+BAT=?

+BAT:254
OK
```

Back

AT+RSSI

Description: Receive signal strength indicator

This command is used to get the RSSI value of the last packet received.

Command	Input Parameter	Return Value	Return Code
`AT+RSSI?`	-	`AT+RSSI` : Get the RSSI of the last received packet	`OK`
`AT+RSSI=?`	-	*< integer > in dBm*	`OK`

> 📝 **NOTE:**
>
> The reply will be **'0'** if there is no last packet received yet.

Examples:

```
AT+RSSI?

AT+RSSI: Last RX packet RSSI
OK

AT+RSSI=?

AT+RSSI:-41
OK
```

Back

AT+SNR

Description: Signal to Noise Ratio

This command is used to get the SNR value of the last packet received.

Command	Input Parameter	Return Value	Return Code
`AT+SNR?`	-	`AT+SNR` : Get the SNR of the last received packet	`OK`
`AT+SNR=?`	-	< *integer* > in dB	`OK`

> 📝 **NOTE:**
>
> The reply will be **'0'** if there is no last packet received yet.

Examples:

```
AT+SNR?

AT+SNR: Last RX packet SNR
OK

AT+SNR=?

AT+SNR:11
OK
```

Back

AT+VER

Description: Version of the firmware

This command is used to get the firmware version installed on the device.

Command	Input Parameter	Return Value	Return Code
`AT+VER?`	-	`AT+VER` : Get the version of the firmware	`OK`
`AT+VER=?`	-	< *V.x.y* >	`OK`

Examples:

```
AT+VER?

AT+VER: Get SW version
OK

AT+VER=?

AT+VER:1.0.0.0 May 27 2021 17:11:12
OK
```

Back

AT+STATUS

Description: Show device status

This command is used to get the current device status.

Command	Input Parameter	Return Value	Return Code
`AT+STATUS?`	-	`AT+STATUS` : Show LoRaWAN status	`OK`
`AT+STATUS=?`	-	< *status* >	`OK`

Examples:

```
AT+STATUS?

AT+STATUS: Show LoRaWAN status
OK

AT+STATUS=?
LoRaWAN status:
   Auto join disabled
   OTAA enabled
   Dev EUI 5032333338350012
   App EUI 1200353833333250
   App Key 503233333835001212003538333332 50
   NWS Key 503233333835001212003538333332 50
   Apps Key 503233333835001212003538333332 50
   Dev Addr 83986D12
   Repeat time 120000
   ADR disabled
   Public Network
   Dutycycle disabled
   Join trials 10
   TX Power 0
   DR 3
   Class 0
   Subband 1
   Fport 2
   Unconfirmed Message
   Region 10
   Network joined
   Mode User

+STATUS:
OK
```

Back

Appendix

Appendix I Data Rate by Region

EU433/EU868/RU864/AS923

Data Rate	Configuration	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50 kbps	50000
8 ~ 15	RFU	

CN470/KR920

Data Rate	Configuration	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6 ~ 15	RFU	

US915

Data Rate	Configuration	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF10 / 125 kHz	980
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
4	LoRa: SF8 / 500 kHz	12500
5 ~ 7	RFU	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500
13	LoRa: SF7 / 500 kHz	21900
14 ~ 15	RFU	

AU915

Data Rate	Configuration	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF8 / 500 kHz	12500
7	RFU	RFU
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500

IN865

Data Rate	Configuration	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	RFU	RFU
7	FSK: 50 kbps	50000
8 ~ 15	RFU	RFU

Back

Appendix II TX Power by Region

EU868

By default, MaxEIRP is considered to be +16 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8 ~ 15	RFU

US915

TXPower	Configuration (Conducted Power)
0	30 dBm - 2*TXpower
1	28 dBm
2	26 dBm
3 ~ 9	-
10	10 dBm
11 ~ 15	RFU

AU915

By default, MaxEIRP is considered to be +30 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1 ~ 10	MaxEIRP - 2*TXPower
11 ~ 10	RFU

KR920

By default, MaxEIRP is considered to be +14 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8 ~ 15	RFU

AS923

By default, Max EIRP is considered to be 16 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8 ~ 15	RFU

IN865

By default, MaxEIRP is considered to be 30 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8	MaxEIRP - 16 dB
9	MaxEIRP - 18 dB
10	MaxEIRP - 20 dB
11 ~ 15	RFU

RU864

By default, MaxEIRP is considered to be +16 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8 ~ 15	RFU

CN470

By default, MaxEIRP is considered to be +19.15 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP 2 dB
2	MaxEIRP 4 dB
3	MaxEIRP 6 dB
4	MaxEIRP 8 dB
5	MaxEIRP - 10 dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8 ~ 15	RFU

EU433

By default, MAxEIRP is considered to be +12.15 dBm.

TXPower	Configuration (EIRP)
0	MaxEIRP
1	MaxEIRP - 2 dB
2	MaxEIRP - 4 dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP - 10 dB
6 ~ 15	RFU

Back

Appendix III Maximum Transmission Load by Region

> 📝 **NOTE:**
>
> M in the following list is the length with MAC header, N is the maximum usable payload size for the user data without MAC header.

EU868

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8 ~ 15	Not Defined	Not Defined

US915

Data Rate	M	N
0	19	11
1	61	53
2	133	125
3	250	242
4	250	242
5 ~ 7	Not Defined	Not Defined
8	61	53
9	137	129
10	250	242
11	250	242
12	250	242
13	250	242
14 ~ 15	Not Defined	Not Defined

AU915

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	Not Defined	Not Defined
8	61	53
9	137	129
10	250	242
11	250	242
12	250	242
13	250	242
14 ~ 15	Not Defined	Not Defined

KR920

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6 ~ 15	Not Defined	Not Defined

AS923

Data Rate	Uplink MAC Payload Size (M)		Downlink MAC Payload Size (M)	
	UplinkDwellTime = 0	UplinkDwellTime = 1	DownlinkDwellTime = 0	DownlinkDwellTime = 1
0	59	N/A	59	N/A
1	59	N/A	59	N/A
2	59	19	59	19
3	123	61	123	61
4	250	133	250	133
5	250	250	250	250
6	250	250	250	250
7	250	250	250	250
8	RFU		RFU	

IN865

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8 ~ 15	Not Defined	Not Defined

RU864

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	230	222
7	230	222
8 ~ 15	Not Defined	Not Defined

CN470

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6 ~ 15	Not Defined	Not Defined

EU433

Data Rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8 ~ 15	Not Defined	Not Defined

Back